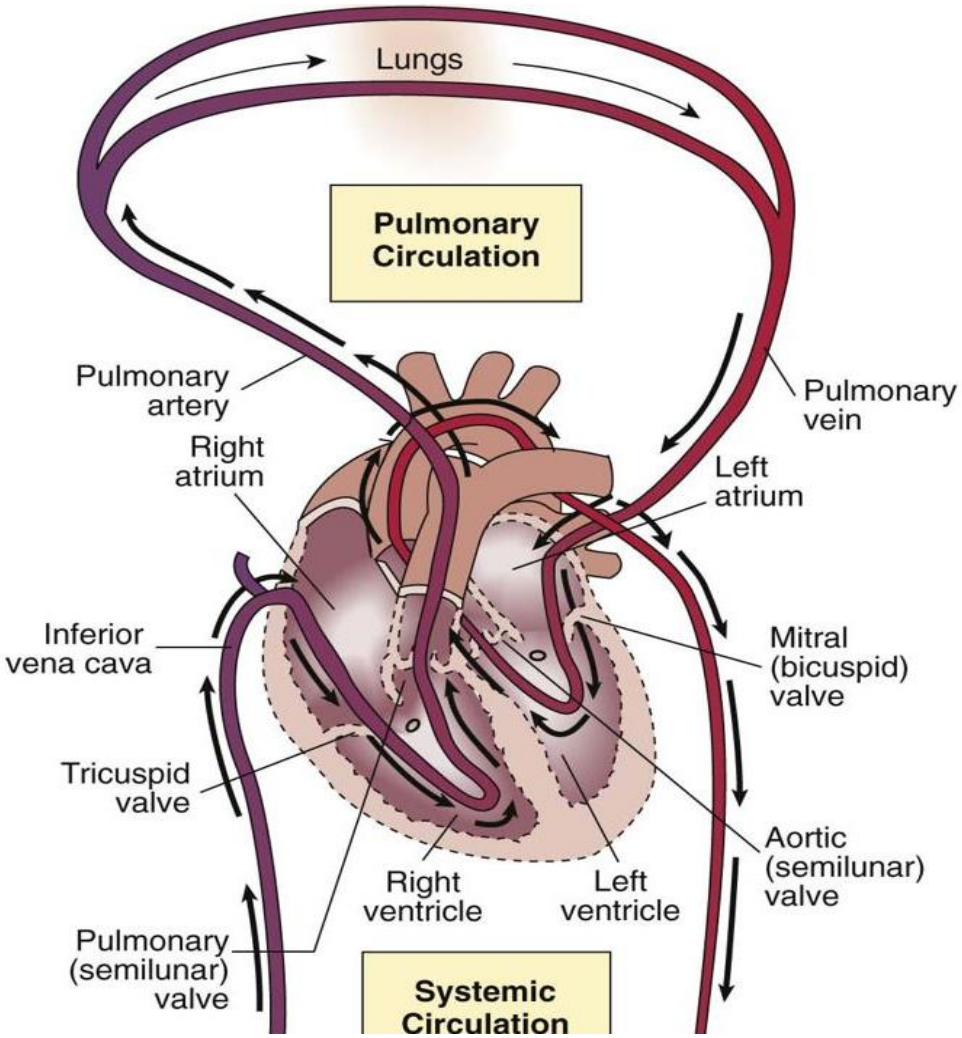
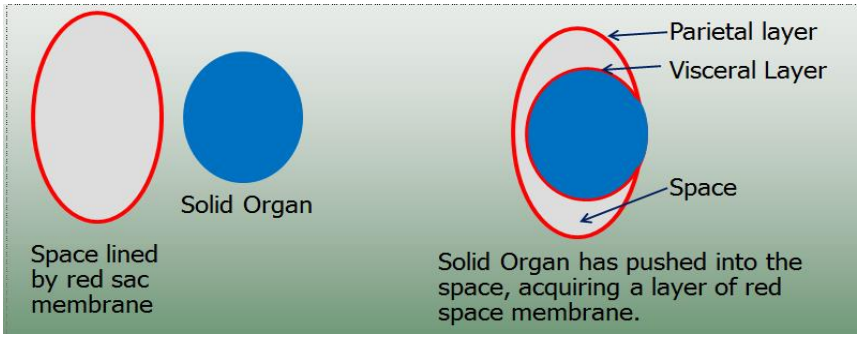
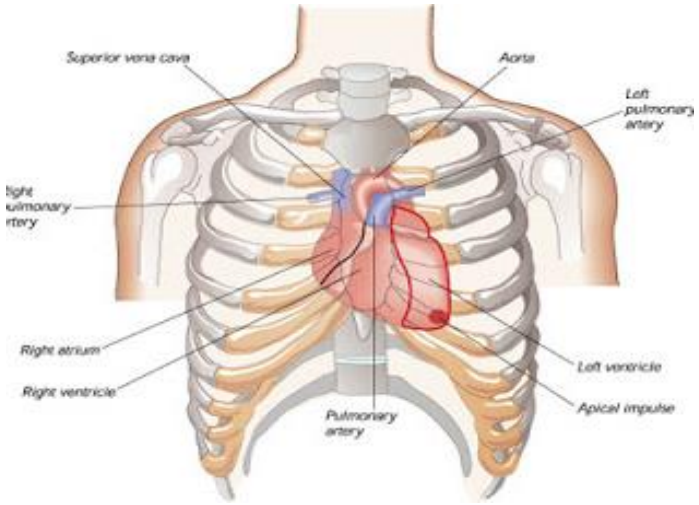
BIOS 2015 … CHAPTER 12- Cardiovascular System Disorders

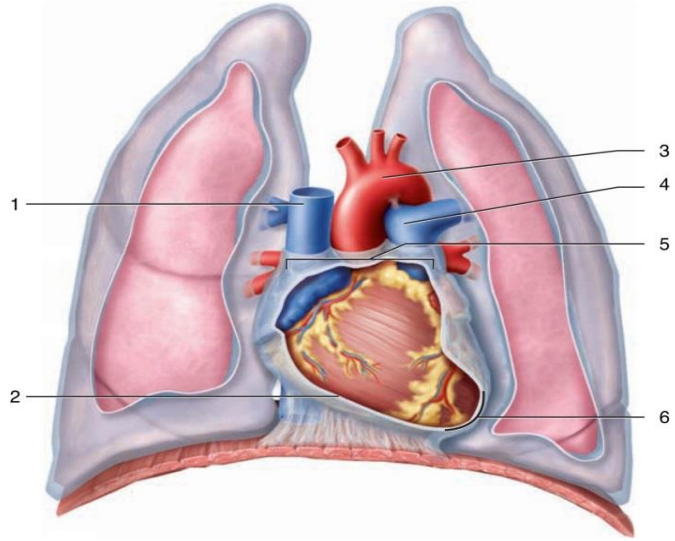
Page	Note
	The circulatory pathway:
	1. blood from upper and lower body collected via superior and inferior vena cavae.
	2. to right atrium
	3. through tricuspid valve to right ventricle
	4. through pulmonic valve to pulmonary artery to lungs (capillary bed)
	5. blood from lungs drains into left atrium
	6. through mital valve to left ventricle
	7. through aortic valve to aorta to all parts of body
	
	Know the names of the chambers, the valves, and the correct order of flow.

How organs get a covering as they develop





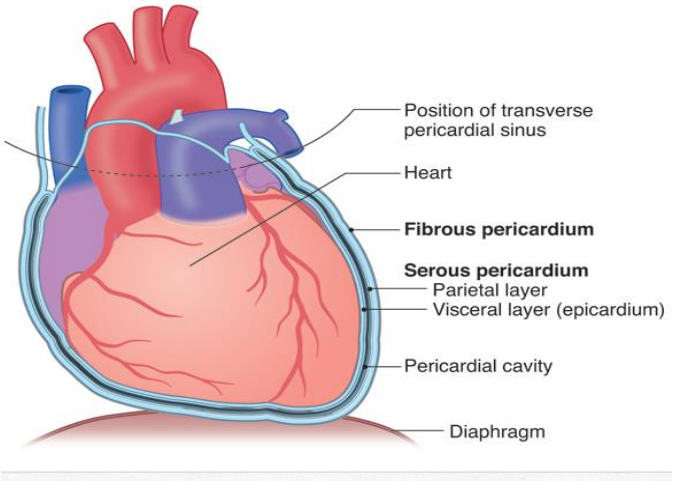
Heart: located in the center of the chest in a space called the "**Mesiastinum".** Note that it is more on lthe left side. The inferior (lower) side rests on the diaphragm.



Heart: is in the peicardial sac made of "pericardium".

Lungs: are in plueral cavities made of "pleura".

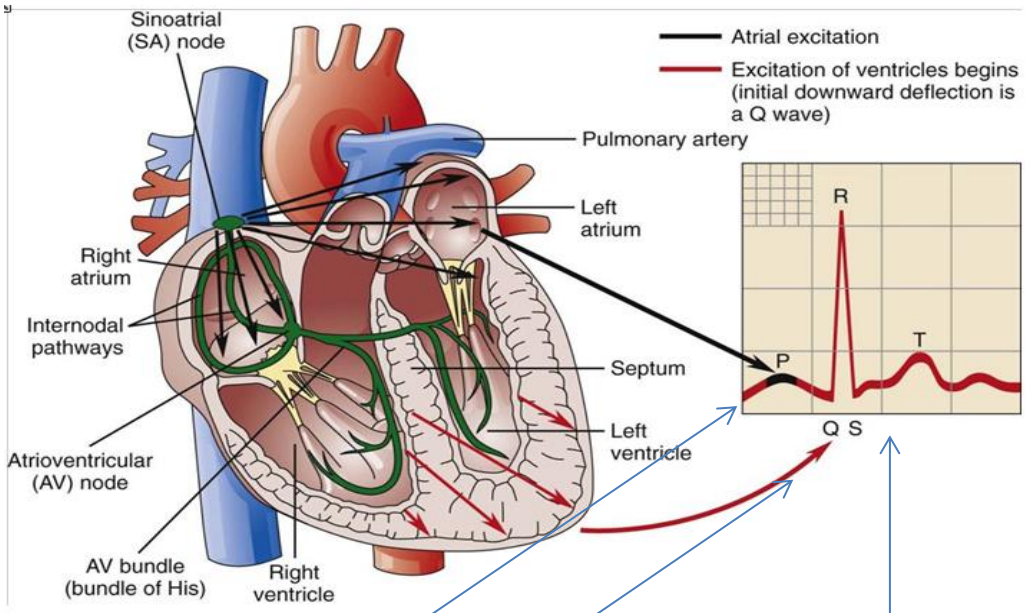
Each has a **visceral layer** that is attached tightly (like a skin) covering the organ and a **parietal layer** that forms the sac and allows space between the visceral and parietal layers.



Notice how the **visceral pericardium** (epicarium) is a skin on the heart and the **parietal pericardium** is the sac wall. The pericardial space is minimal under normal conditions.

Conduction System:

SA node > AV node > Bundle of His > Right and Left Bundle Branches > Purkinje Fibers



P wave Depolarization of atria

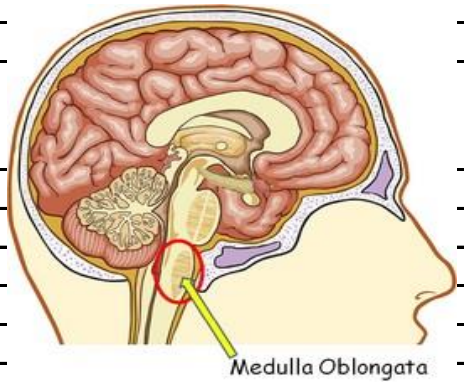
QRS wave Depolarization of ventricles

T wave Repolarization of ventricles

Cardiac control center in medulla oblongata

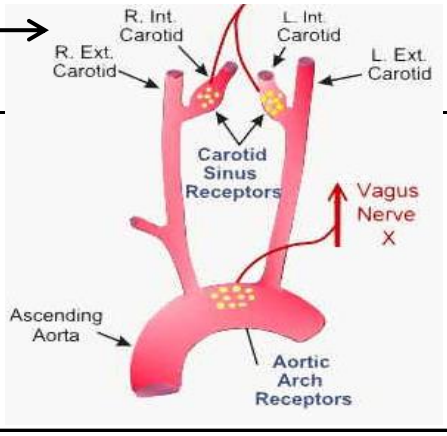
Controls rate and force of contraction

Located in the medulla



Control of Heart

Baroreceptors
Detect changes in blood pressure
Located in the aorta and internal carotid arteries

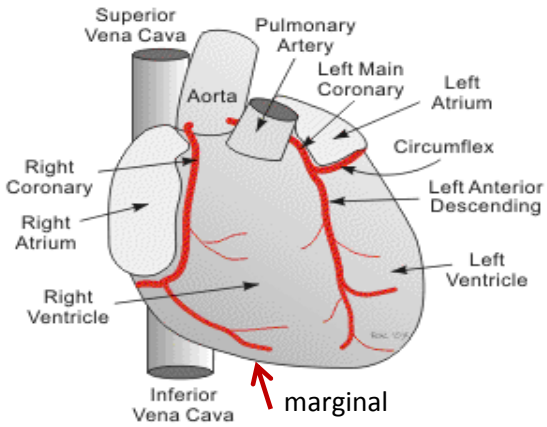


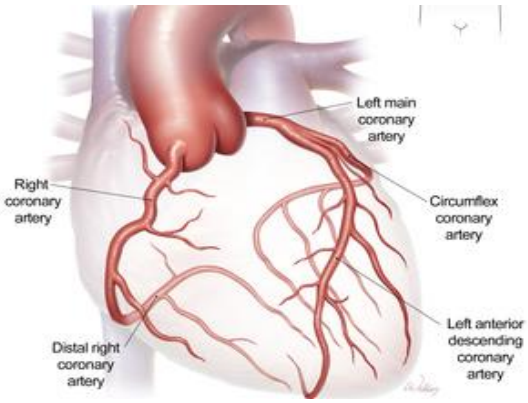
Sympathetic stimulation
(cardiac accelerator nerve)
Increases heart rate (tachycardia)
.....
Parasympathetic stimulation
(cranial nerve [CN] X; vagus nerve)
Decreases heart rate (bradycardia)

Factors that Increase Heart Rate

- Increased thyroid hormones or epinephrine
- Elevated body temperature, infection Example: Fever
- Increased environmental temperature
- Especially in high humidity
- Exertion or exercise
- Smoking
- Stress response
- Pregnancy
- Pain

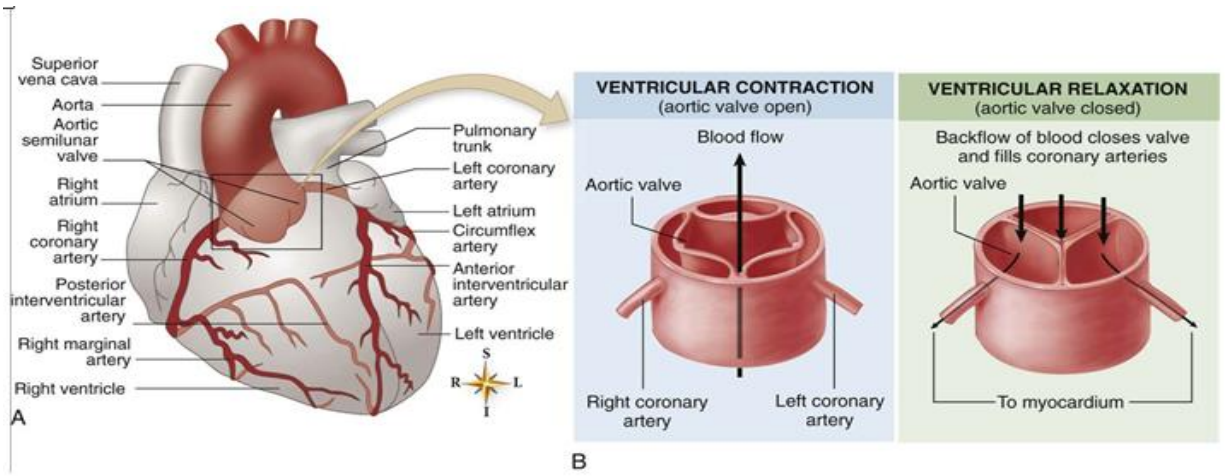
Coronary Circulation



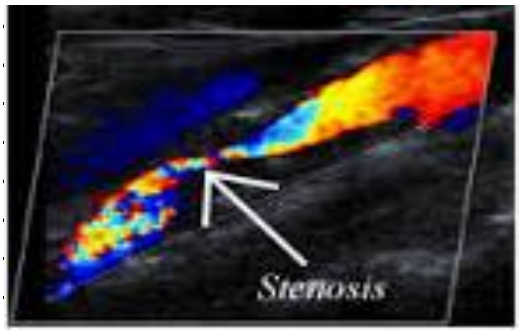


Right and left coronary arteries:
Branch of aorta immediately distal to the aortic valve
Part of the systemic circulation
Left coronary artery divides into:
Left anterior descending or interventricular artery
Left circumflex artery
Right coronary artery branches:
Right marginal artery
Posterior interventricular artery (sometimes)

Note: Left circumflex and right coronary arteries circle around to back of heart and one of them will drop a posterior descending artery along interventricular septum.

	Cardiac Cycle
	Diastole Relaxation of myocardium required for filling chambers **Systole** Contraction of myocardium provides increase in pressure to eject blood **Cycle begins with** Atria relaxed, filling with blood > AV valves open > blood flows into ventricles > atria contract, remaining blood forced into ventricles > atria relax > ventricles contract > AV valves close > semilunar valves open > blood into aorta and pulmonary artery > ventricles relax
	
	Heart Sounds - heard in stethoscope
	"Lubb-dub" "Lubb"—closure of AV valves (tricuspid and mitral) "Dub"—closure of semilunar valves (aortic and pulmonic) **Murmurs** Caused by incompetent valves and septal defects
	Cardiac Function
	Cardiac output (CO) Blood ejected by a ventricle in 1 minute
	Stroke volume (SV) Volume of blood pumped out of ventricle—contraction
	CO = SV · HR (heart rate in beats per minute)
	Preload Pressure from all the blood collected before systole (ventricular contraction). **Afterload** Pressure pumped against in systole due to periferal vascular resistence.
	Blood pressure affected by:
	1. Sympathetic Nervous System - affecting heat rate and peripheral vascular resistence (faster rate and increased resistence raise blood pressure).
	2. Blood volume (bigger volume = higher pressure)
	3. Hormones that retain water and salt or vasoconstrict the periphery, elevate blood pressure

	Heart Disease
	Diagnostic Tests for Cardiovascular Function:
	1. Electrocardiography (ECG or EKG)
	2. Auscultation - listen with stethoscope.
	3. Echocardiography (ultrasound) - imaging that shows motion (doppler adds specific information about flow dynamics)
	4. Stress test - ECG while on treadmill.
	5. Chest X-Ray
	6. Catheterization - measures pressures.
	7. Angiography - injects dye that can be seen with X-rays into individual blood vessels (like coronary arteris), shows if vessels are open, narrowed or blocked.
	8. Doppler studies - special ultrasound that shows blood flow and vessel blockage.
	9. Arterial Blood Gas determination - measures oxygen and acid-base status in the blood.



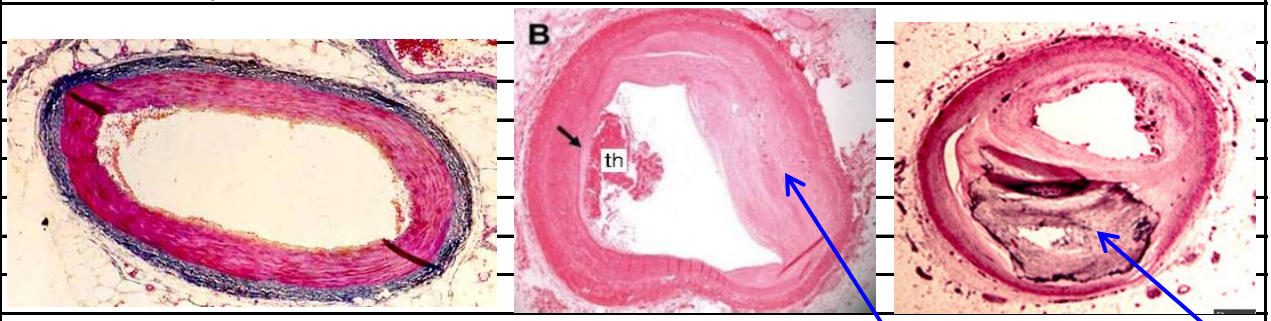
Chest X-Ray **Coronary Angiography** **Doppler showing stenosis**

	General Treatment Measures for Cardiac Disorders
	Dietary modifications To decrease total fat intake General weight reduction Reduce salt intake **Regular exercise program** Increases high-density lipoprotein levels Lowers serum lipid levels Reduces stress levels **Cessation of smoking** Decreases risk of coronary diseaseCessation of smoking **Drugs** > Reduce peipheral resistence, lower blood presure. > Treat arrhythmias. > Diuretics, reduce excess fluid and salts. > Anticoagulents to avoid blood clots. > Cholesterol lowering drugs to reduce atherosclerosis.

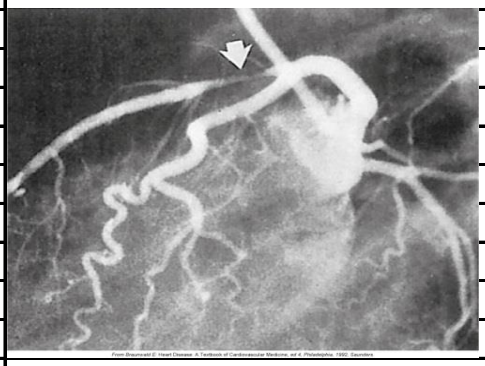
Coronary Artery Disease (CAD)

Atherosclerois

Degenerative disease of arteries that allows build up of lipid (fat), scar, calcium deposits, and thrombi (blood clots) in the blood vessel wall. This progressively narrows the blod vessel till it is completely blocked at which point tissue distal to the block will infarct and become necrotic.



Normal - wide open lumen Lumen narrowed by fibrous plaque and complicated plaque



Coronary artery angiography shows narrowing of one artery.

Lipid Transport is important to the formation of atherosclerosis:

Lipids are transported in combination with proteins.
Low-density lipoprotein (LDL) - the bad lipoproteins
Transports cholesterol from liver to cells
Major factor contributing to atheroma formation
High-density lipoprotein (HDL) - the good lipoprotiens
Transports cholesterol away from the peripheral cells to liver—"good" lipoprotein
Catabolism in liver and excretion

Risk Factors for Atherosclerosis

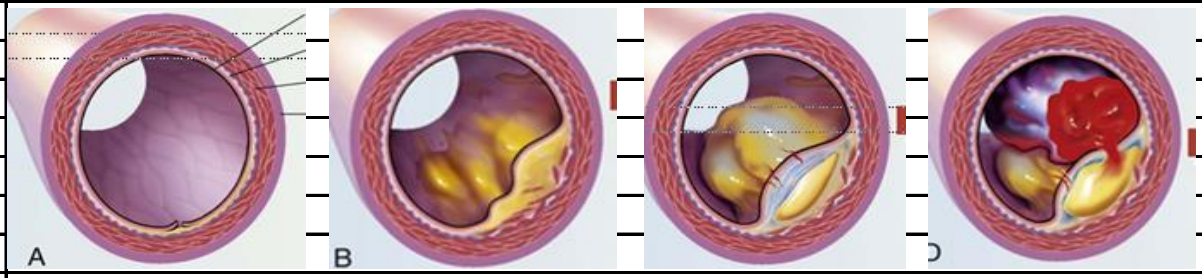
Nonmodifiable
Age
Gender
Genetic or familial factors
Modifiable
Obesity
Sedentary lifestyle
Cigarette smoking
Diabetes mellitus
Poorly controlled hypertension
Combination of oral contraceptives and smoking

Treatment of Atherosclerosis - target the modifiable risk factors:

Diagnostic tests
Serum lipid levels

Treatment
Weight loss
Increase exercise.
Lower total serum cholesterol and LDL levels by dietary modification.
Reduce sodium intake.
Control hypertension.
Cessation of smoking
Antilipidemic drugs
Surgical intervention, such as coronary artery bypass grafting

Progression of Atherosclerosis



Normal >>>>>>>>> Fatty Streak >>>>>>> Fibrous Plaque >>>>>Complicated Plaque

Complicated plaques contain fat, scar, large calcific deposits, and thrombus (blood clot).

If thrombi break loose, they become **EMBOLI** that can travel in the blood stream to a distant site. If the make it to the lungs, they can not traverse the capillar bed and they become lodged in the first vessel they encounter that is smaller in diameter than the embolus.

Embolic occlusion of a blood vessel will infarct tissue distal to the block unless there is collateral circulation to by pass the block.

End Arteries:

Collaterals

The coronary artery system in the heart has NO collateral circulation; so blockage of a coronary artery will result in a myocardial infarct (death of heart muscle tissue) if the blockage is not rapidly cleared.

Angina Pectoris - chest pain when the heart does not get enough oxygen to meet the current needs of the heart muscle. Demands for oxygen increase with exercise; that is why the pain may begin with strenuous activity and abate with rest.

Emergency Treatment for Angina

Rest, stop activity
Patient seated in upright position
Administration of nitroglycerin—sublingual
Check pulse and respiration.
Administer oxygen, if necessary.

	Warning Signs of Heart Attack
	Feeling of pressure, heaviness, or burning **in chest**—especially with increased activity Sudden **shortness of breath**, weakness, fatigue **Nausea**, indigestion Anxiety and fear **Pain may occur and, if present, is usually** **Substernal** **Crushing** **Radiating (to left arm).**
	Diagnosis of Myocardial Infarcy (Heart Attack)
	EKG changes, Specific Isozymes in blood, Elevated serum myosin and cariac troponin, Leukocytosis, elevated CRP and ESR, **altered blood gases (lower oxygen and acidosis).**
	Myocardial Infarction: Complications
	Sudden death Cardiogenic shock Congestive heart failure Rupture of necrotic heart tissue/cardiac tamponade Thromboembolism causing cerebrovascular accident (CVA; with left ventricular MI)
	Treatment of a Myocardial Infarct
	Reduce cardiac demand. Oxygen therapy Analgesics Anticoagulants Thrombolytic agents may be used (thrombolytic - lyses or dissolves a thrombus [blood clot] that is blocking the coronary artery) Tissue plasminogen activator Medication to treat: Dysrhythmias, hypertension, congestive heart failure Cardiac rehabilitation begins immediately.
	Cardiac Dysrhythmias (Arrhythmias)
	The abnormal wave forms can be seen with an EKG.
	Irregular heart beats (arrhythmias) occur as many different types, and each is treated with a regiment specific for that arrhythmia.
	Treatments include a wide variety of **drugs**. In some cases an artificial **pacemanker** and/or a **defibrillator** is installed.
	Bradycardia Regular but **slow** heart rate **Tachycardia** Regular **rapid** heart rate
	Ventricular Fibrillation - a heart beat so rapid that there is no effective muscle contraction to maintain blood pressure. Ofen need to use cardioversion (shocking the heart) to restoes a functinal rhythm. If there is a chronic problem, a defibillator can be implanted in the patient.
	Congestive Heart Failure
	Heart is unable to pump out sufficient blood to meet metabolic demands of the body
	Left Heart Failure:
	1. back pressure on lungs >>> pulmonary edema >>> short of breath
	2. loss of forward pressure decreases blood pressure, circulation and oxygenation of the tissues.

Right Heart Filure

1. back pressure on the superior and inferior vena cavae

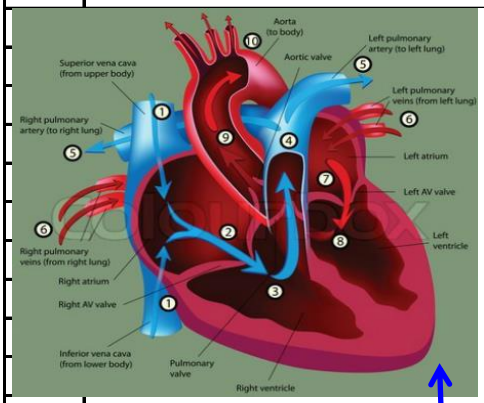
superior: leads to distended neck veins

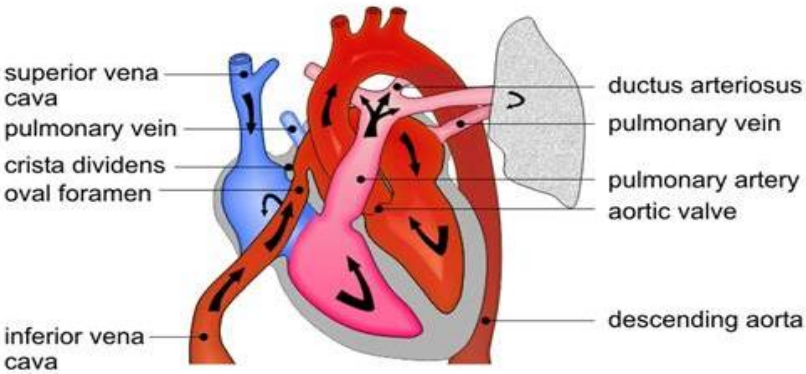
inferior: leads to congestion of liver and spleen and edema of lower extremities and ascites (fluid collection in the peritoneal [abdominal] cavitiy.)

2. loss of forward pressure decreases blood flow to the lungs and oxygenation of the blood.

CONGENITAL HEART DEFECTS - Inherited structural abnomalities of the heart

- some are severe and present at birth as life threatening conditions.
- some are mild and present later in life.





Normal flow after birth:

Fetal circulation (in utero):

1. Oxygenated blood from the placenta enters the right atrium

2. Some of that blood traverses the **foramen ovale** to get from the right atrium to the left atrium

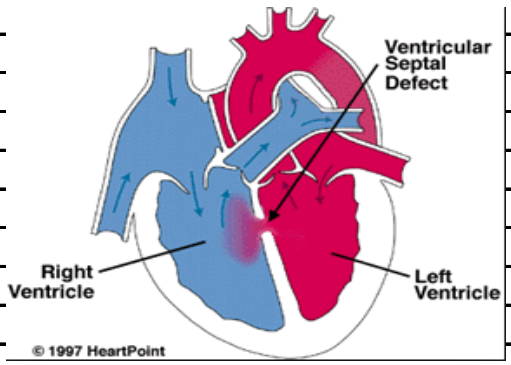
3. Some of that blood leaves the right atrium and goes to the right ventricle. It then is pumped into the pulmonary artery, but before it gets to the lungs, it takes a short cut through the **ductus arteriosus** and enters the aorta.

The foramen ovale and ductus arteriosus allow oxygenated blood in the fetus to bypass the lungs and get to the tissues faster.

Tools to study the heart:

Radiography (xrays)
Diagnostic imaging (CT, MRI)
Cardiac catheterization (measures pressures and can be used for angiograhy)
Echocardiography (ultrasound, shows movement)
Electrocardiography (ECG or EKG)

Ventricular Septal Defect



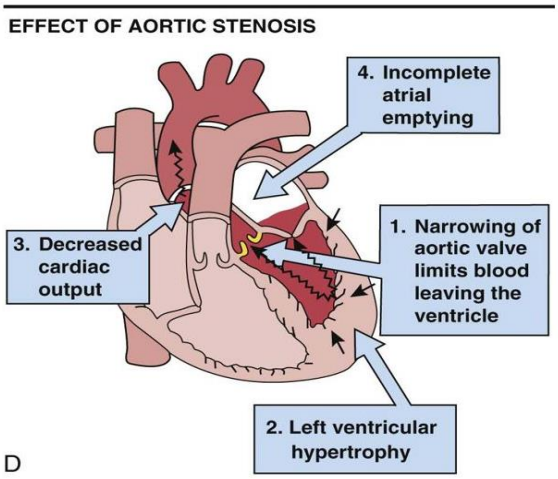
1. Blood moves from the left ventricle to the right ventricle.
2. This produces excess volume in the right ventricle.
3. This leads to pulmonary hypertension.

Valve Disease:

Stenosis: Narrowing of a valve by scar or atherosclerotic plaque. This produces back pressure prominal to the blockage and lower pressure distal to the blockage.

Incompetant Valve: This vale is unable to keep blood from going backward (referred to as "regurgitation")

Abnormal valves can be treated surgically by valve replacement using a mechanical or animal valve.

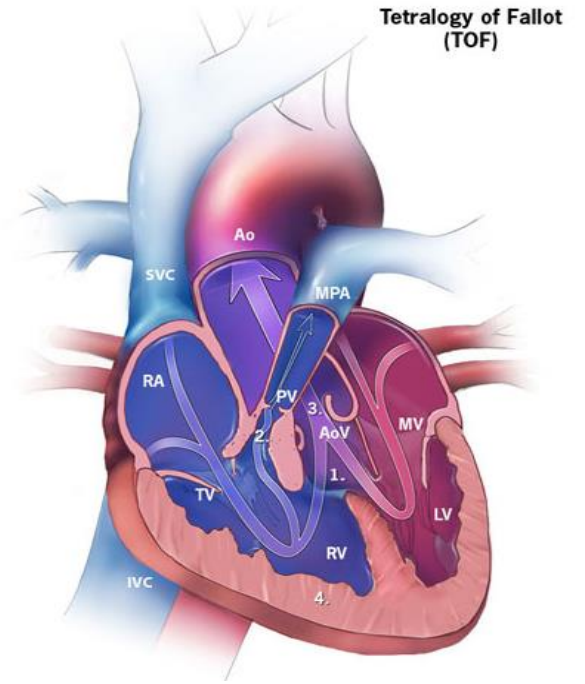


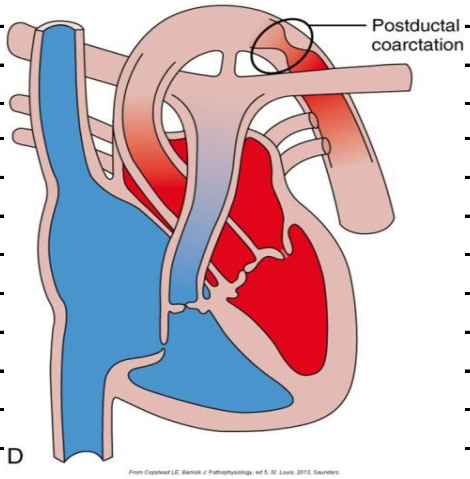
AORTIC STENOSIS:
Narowing of aortic valve can result in left heat failure.

Tetralogy of Fallot (named after French physician Étienne-Louis Arthur Fallot):

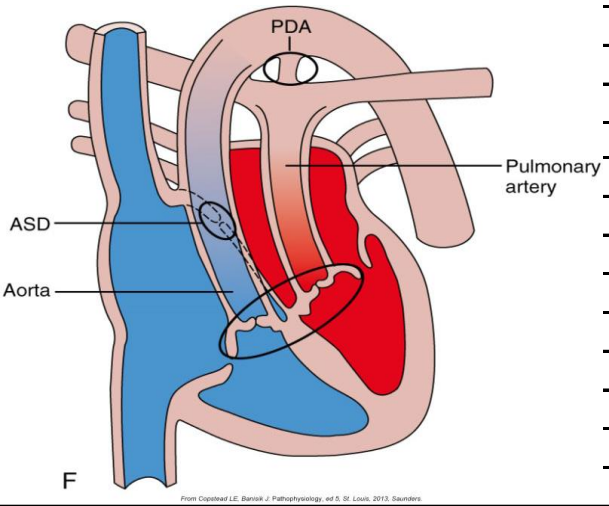
Tetralogy has "Tetra" which means four.

This syndrome is composed of 4 findings:
1. Pulmonic stenosis (pulmonic valve narrowed)
2. Ventricular Septal Defect (VSD).
3. Dextroposition of the aorta ("dextro"- right sided positioning of the aortic root over the right ventricle).
4. Right ventricular hypertrophy (because the right ventricle is doing the left ventricle job, pumping blood out the aorta).



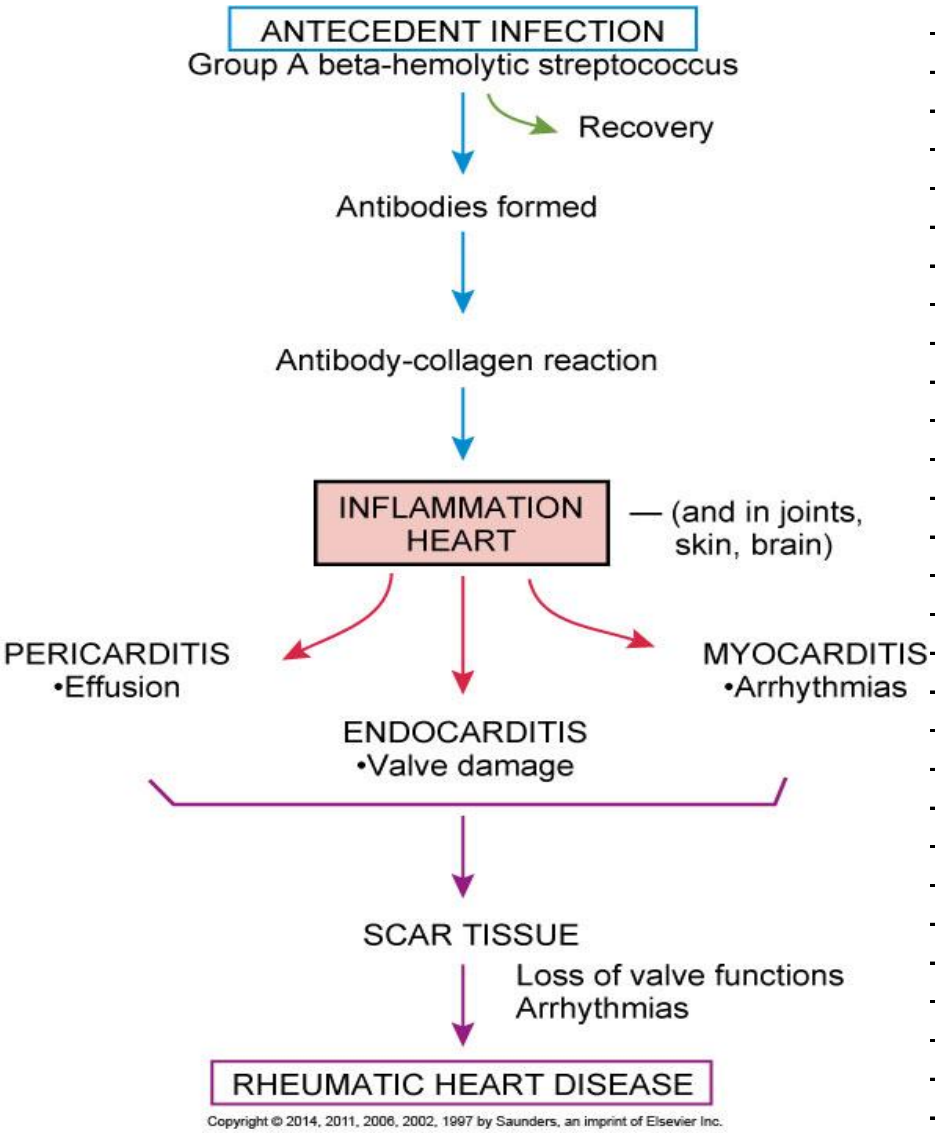


COARC of Aorta



Transposition of the Great Arteries.

RHEUMATIC FEVER

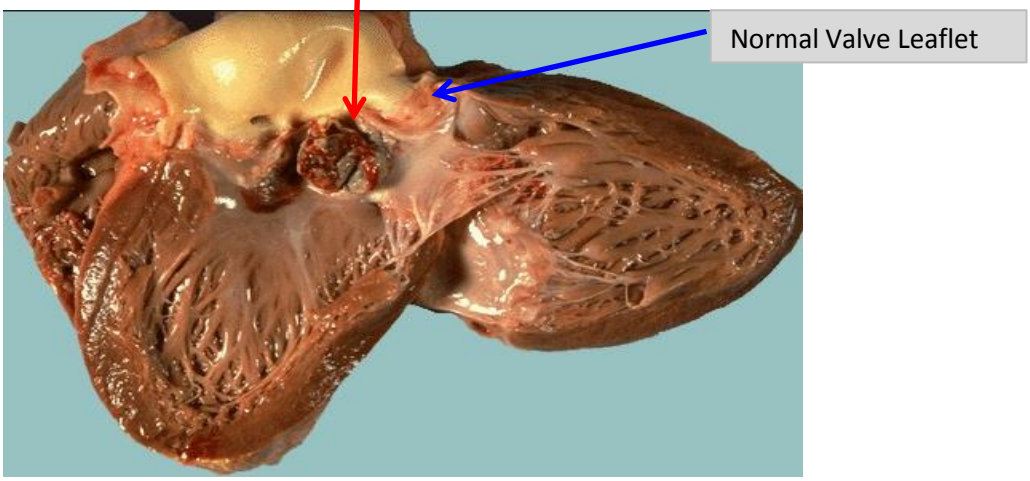


Rheumatic Heart Disease:

- **diagnosis** may involve studies of heart function and **ASO titer.**

Infective Endocarditis

- can result in **bacterial vegitations** on the aortic valve, bits can break off and seed the brain producing brain abscesses.



- Subacute caused by **Strep viridans**; **Acute** caused by **Staph aureus.**

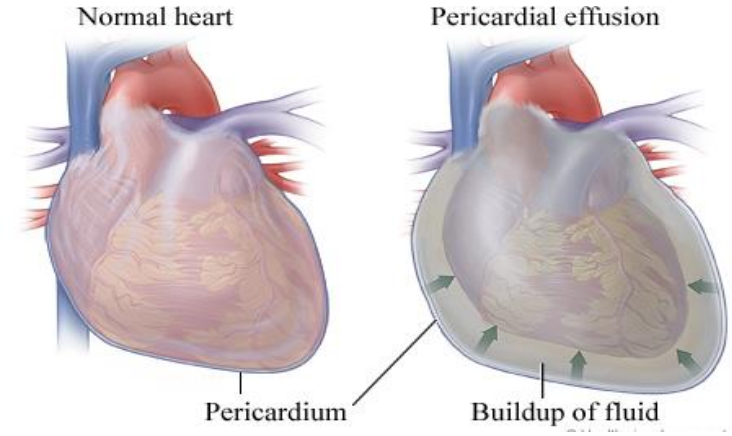
- Rhematic valves are sensitive to bacterial infection, so protective antibiotics may be given if bacteremia is anticipated, like in a teeth cleaning.

Pericarditis:

Inflammation of the pericardium.

Many causes. **Viral infection and cancer** are two to remember.

Pericardial effusion may develop. This may press on the heart and limit the amount of blood it can pump.



Pericarditis can end in scarring of the peicardial sac producing a **restricive disease**. A scarred nonpliable sac limits the amount of blood the ventricles can pump.

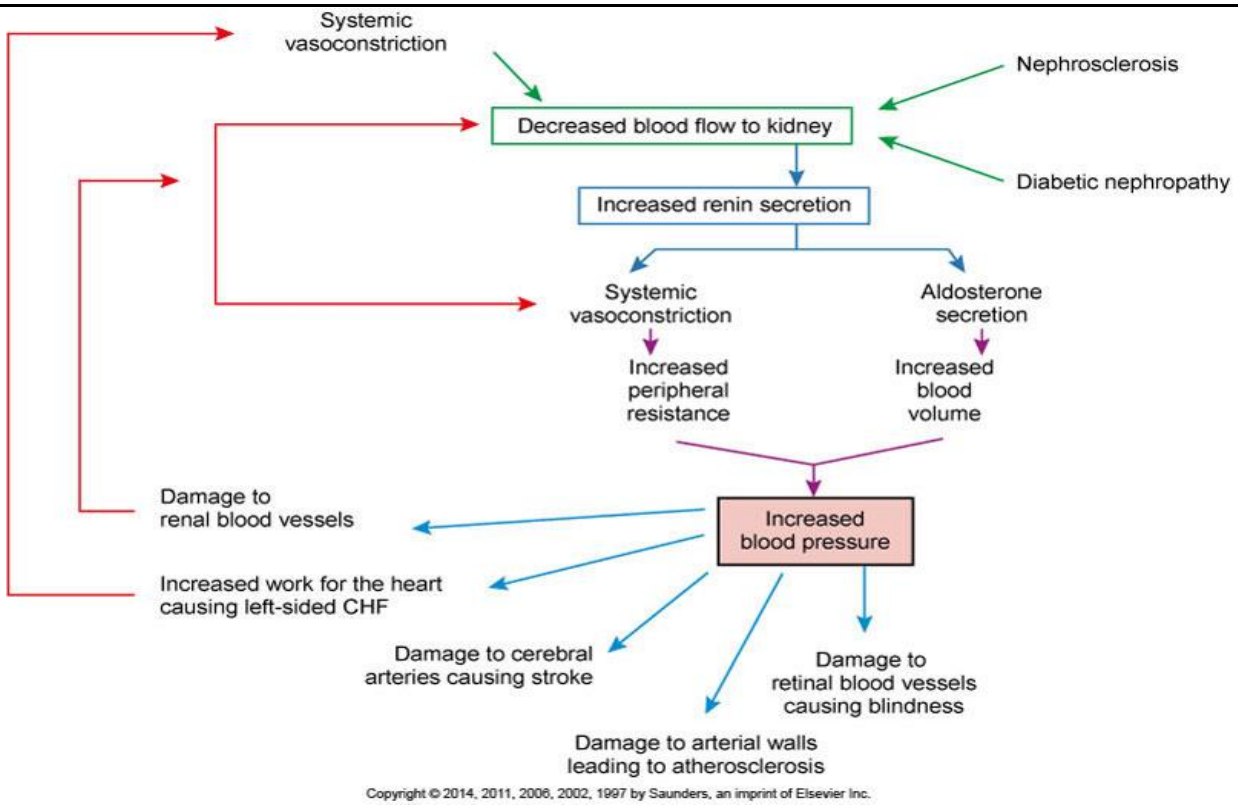
Hypertension - High Blood Presure

Primary or Essential hypertension
Blood pressure consistently above 140/90 mm Hg
May be adjusted for age
Increase in arteriolar vasoconstriction
Over long period of time—damage to arterial walls
Blood supply to involved area is reduced.
Ischemia and necrosis of tissues, with loss of function

Secondary hypertension
Results from renal or endocrine disease, pheochromocytoma (benign tumor of the adrenal medulla)
Underlying problem must be treated to reduce blood pressure.

Malignant or resistant hypertension
Uncontrollable, severe, and rapidly progressive form with many complications
Diastolic pressure is extremely high.

Development of Hypertension



Areas most frequently damaged by hypertension

Kidneys, Heart, Brain, Retina

Predisposing factors

Incidence increases with age.
Men affected more frequently and more severely
Incidence in women increases after middle age.
Genetic factors
Sodium intake, excessive alcohol intake, obesity, smoking, prolonged or recurrent stress

Hypertension

Frequently asymptomatic in early stages
Initial signs vague and nonspecific
Fatigue, malaise, sometimes morning occipital headache

Essential hypertension treated in steps
Lifestyle changes
Reduction of sodium intake
Weight reduction
Reduction of stress
Drugs
Diuretics (drugs that make the kidney loose fluid and salts - leads to copius urination), ACE inhibitors, drug combinations

Peripheral Vascular Disease: Atherosclerosis

Disease in arteries outside the heart
Increased incidence with diabetes
Most common sites: Abdominal aorta, Carotid arteries, Femoral and iliac arteries
Diagnostic tests
Blood flow assessed by Doppler studies and arteriography

Atherosclerosis occludes blood vessels robbing the tissue of oxygen

In the heart - produces the chest pain of a heart attack.

In the intestines - abdominal pain.

In the legs - **leg pain** known as **claudication**

- also presents with muscle weakness
- sensory impairment (tingling, burning, numbness)
- pale or blue color
- skin that is dry and hairless (stasis dermatitis)
- Weak distal pulses (like pedal pulse on dorsum of foot).

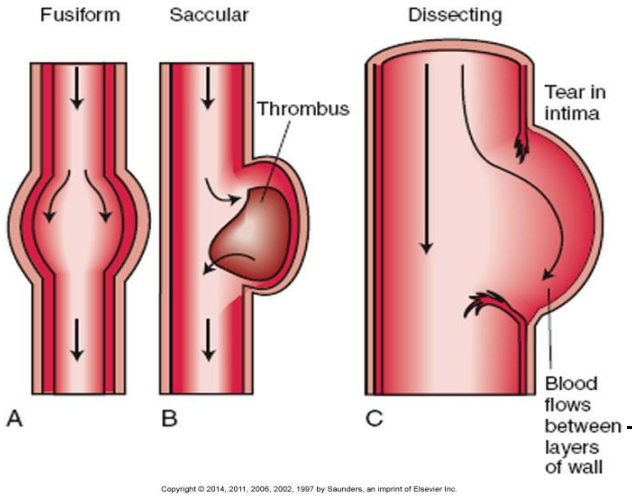
Treatment:

Maintain control of blood glucose level.
Reduce body mass index.
Reduce serum cholesterol level.
Platelet inhibitors or anticoagulant medication
Cessation of smoking
Increase activity and exercise
Maintain dependent position for legs—improves arterial perfusion
Peripheral vasodilators
Observe skin for breakdown and treat promptly.
If gangrene develops, amputation is required.

ANEURYSM

- Localized dilation and weakening of arterial wall
- Develops from a defect in the medial layer

Types of Aortic Aneurysms



Varicose Veins:

- Irregular, dilated, tortuous areas of superficial veins, may be painful.

- can be a dangerous place for thrombi to form and become emboli.

clotting, and sometimes surgery (vein stripping).

Thrombophlebitis - inflammation of a vein.

Phlebothrombosis - thrombosis of a vein.

	SHOCK
	Shock or hypotension results from a decreased circulating blood volume, leading to decreased tissue perfusion and general hypoxia. In most cases, cardiac output is low.
	SEE TABLE BWLOW - KNOW HE DIFFERNET TYPES OF SHOCK,THE MECHANISM, AND A FEW CAUSES.

Type	Mechanism	Specific Causes
Hypovolemic	Loss of blood or plasma	Hemorrhage, burns, dehydration, peritonitis, pancreatitis
Cardiogenic	Decreased pumping capability of the heart	Myocardial infarction of left ventricle, cardiac arrhythmia, pulmonary embolus, cardiac tamponade
Vasogenic (neurogenic or distributive)	Vasodilation owing to loss of sympathetic and vasomotor tone	Pain and fear, spinal cord injury, hypoglycemia (insulin shock)
Anaphylactic	Systemic vasodilation and increased permeability owing to severe allergic reaction	Insect stings, drugs, nuts, shellfish
Septic (endotoxic)	Vasodilation owing to severe infection, often with gram-negative bacteria	Virulent microorganisms (gram-negative bacteria) or multiple infections